Final report for project NAG-2-1576, entitled: "*In situ* aerosol profile measurements and comparisons with SAGE III aerosol extinction and surface area profiles at 68° North".

Under funding from this proposal three *in situ* profile measurements of stratospheric sulfate aerosol and ozone were completed from balloon-borne platforms. The following table provides the dates, time of release, location of balloon release, species measured, and the file name containing the vertical profile of the species measured. The measured quantities are aerosol size resolved number concentration and ozone. The one derived product is aerosol size distribution, from which aerosol moments, such as surface area, volume, and extinction can be calculated for comparison with SAGE III measurements and SAGE III derived products, such as surface area. Figures 1 through 3 provide an overview of the aerosol, ozone, and temperature measurements available from each flight. All files are archived in NASA Ames format on NASA's publicly available ftp site at http://espoarchive.nasa.gov/archive/arcs/solve2/data/balloon/.

The analysis of these profiles and comparison with SAGE III extinction measurements and SAGE III derived surface areas are provided in Yongxiao [2005], which comprised the research thesis component of Mr. Jian Yongxiao's M.S. degree in Atmospheric Science at the University of Wyoming. In addition analysis continues on using principal component analysis (PCA) to derive aerosol surface area from the 9 wavelength extinction measurements available from SAGE III. This paper [Yongxiao and Deshler, 2005] will present PCA components to calculate surface area from SAGE III measurements and compare these derived surface areas with those available directly from *in situ* size distribution measurements, as well as surface areas which would be derived from PCA and Thomason's algorithm [Thomason and Osborn, 1992] applied to the four wavelength SAGE II extinction measurements.

Abstract of Yongxiao's thesis: The inversion of satellite extinction measurements to obtain aerosol surface area and volume is compared with direct in situ size distribution measurements. A principal component analysis (PCA) is used to retrieve aerosol moments from satellite multi-wavelength extinction measurements during volcanically perturbed and tranquil periods. The satellite measurements investigated are Stratospheric Aerosol and Gas Experiment (SAGE) II and SAGE III. The in situ measurements are from University of Wyoming balloon-borne measurements with optical particle counters. The comparisons indicate that estimates of surface area from PCA applied to extinction measurements is generally smaller than direct integrations of aerosol size distributions to obtain surface area. During the volcanically tranquil period the underestimations increase and the underestimations of surface area by SAGE II are more than the underestimations of volume. Case studies of the PCA method applied to SAGE III 9-wavelength extinction measurements indicate better agreement with in situ measurements compared to SAGE II 4-wavelength measurements during the volcanically tranquil period. A correction method, using an analytic function of estimated effective radius to simulate relative errors between the integral of size distributions and the PCA of extinctions, is proposed to correct satellite estimates of aerosol surface area. This correction improves the estimates from multi-wavelength extinction measurements especially during low aerosol loading, i.e. for measurements above 25 km or during volcanically quiescent periods.

There were no inventions associated with this grant. There was no property purchased with funds for this grant.

Yongxiao, Jian, An assessment of retrieval of stratospheric aerosol moments from SAGE II and SAGE III extinction measurements. M.S. Thesis, University of Wyoming, 76 pp, May 2005.

Yongxiao, J., and T. Deshler, 2005, Retrieval of aerosol surface area from multi-wavelength extinction measurements during high and low stratospheric aerosol loading, *Geophys. Res. Lett.*, to be submitted in May 2005.

Thomason, L. W., and M. T. Osborn, Lidar conversion parameters derived from SAGE II extinction measurements, *Geophys. Res. Lett., 19*, 1655-1658, 1992..

Table. List of in situ vertical profile measurements of aerosol and ozone. The date, time, and location of balloon release are included along with maximum altitude in mbar, species measured and NASA Ames archived data file on the public data base, http://espoarchive.nasa.gov/archive/arcs/solve2/data/balloon/.

Year	Month	Day	Launch time (UT)	Latitude	Longitude	Max Altitude (mbar)	Species measured	Archive file name
2002	**12**	**3**	**9:59**	**67.9**	**21.1**	**19.4**	Aerosol number concentration (ascent)	Ki20021203__nra.bal
							Aerosol number concentration (descent)	Ki20021203__nrd.bal
							Aerosol size distribution (ascent)	Ki20021203__sda.bal
							Ozone (ascent)	Ki20021203__o3a.bal
							Ozone (descent)	Ki20021203__o3d.bal
2003	**7**	**28**	**12:42**	**41.33**	**105.67**	**8.7**	Aerosol number concentration (ascent)	Ki20030728__nra.bal
							Aerosol number concentration (descent)	Ki20030728__nrd.bal
							Aerosol size distribution (ascent)	Ki20030728__sda.bal
							Ozone (ascent)	Ki20030728__o3a.bal
							Ozone (descent)	Ki20030728__o3d.bal
2004	**1**	**10**	**5:50**	**67.9**	**21.1**	**11.6**	Aerosol number concentration (ascent)	Ki20040110__nra.bal
							Aerosol number concentration (descent)	Ki20040110__nrd.bal
							Aerosol size distribution (ascent)	Ki20040110__sda.bal
							Ozone (ascent)	Ki20040110__o3a.bal
							Ozone (descent)	Ki20040110__o3d.bal

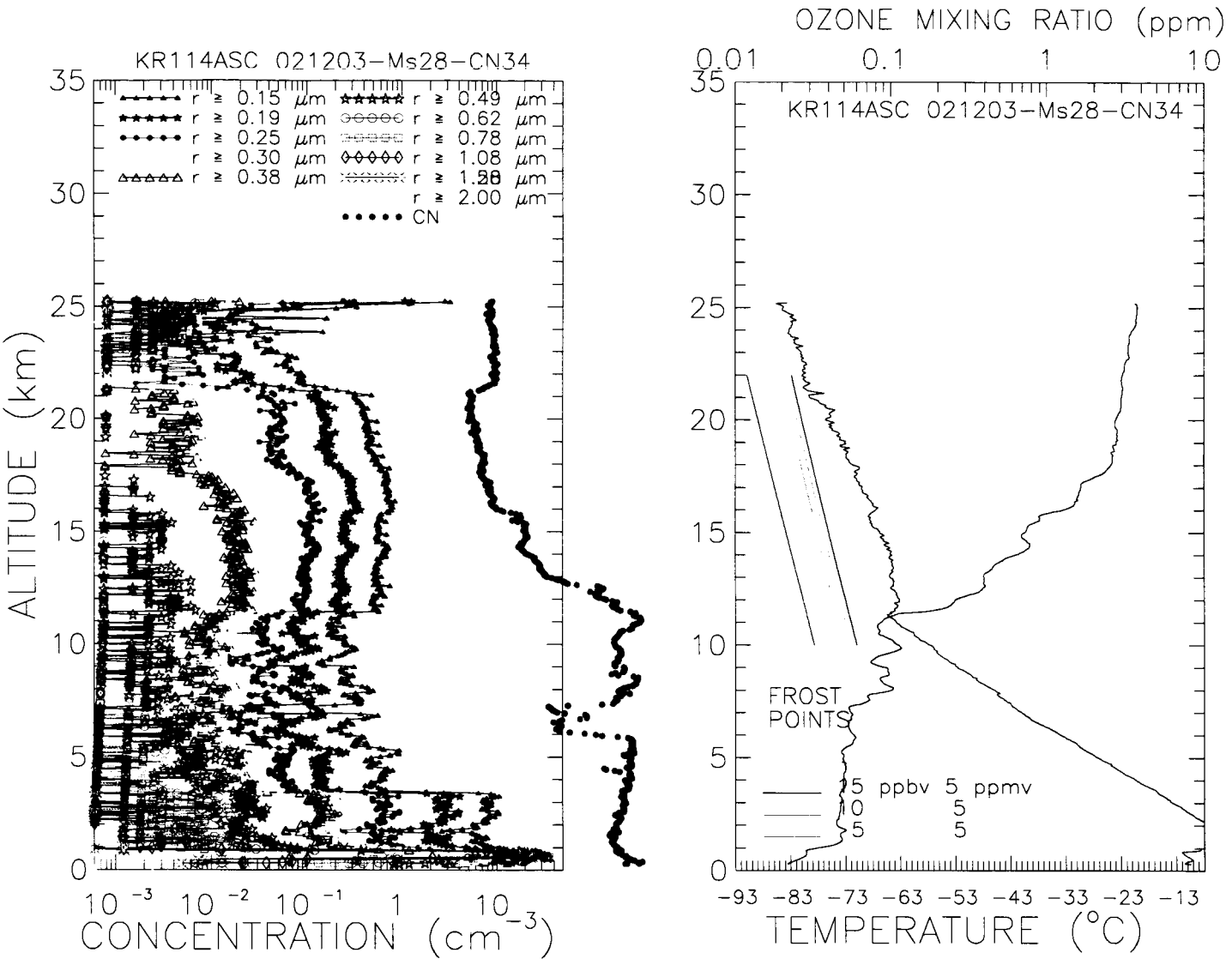

Figure 1. Balloon-borne measurements completed on 3 December 2002. The balloon was released from Esrange, Sweden. Left hand panel: vertical profiles of the concentration (cm^{-3}) of CN ($r > 0.01$ μm) and aerosol with radius > 0.15 μm in 12 sizes. Right hand panel: ozone mixing ratio (top axis) and temperature (bottom axis). For reference the temperature is compared to equilibrium coexistence temperatures for nitric acid trihydrate and ice which form within polar stratospheric clouds. Clearly above 21 km a polar stratospheric cloud was encountered.

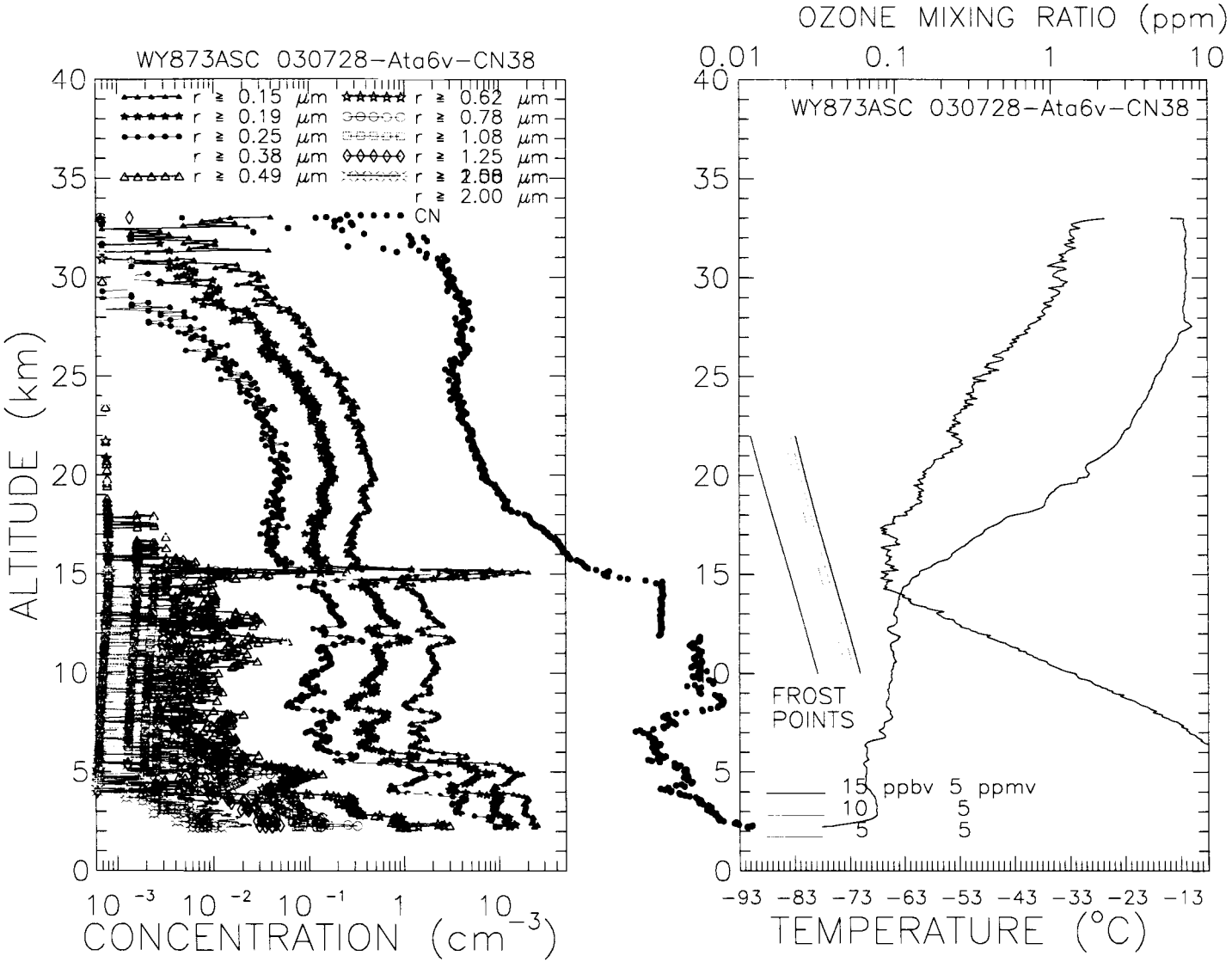

Figure 2. Balloon-borne measurements completed on 28 July 2003. The balloon was released from Laramie, Wyoming, USA. Left hand panel: vertical profiles of the concentration (cm^{-3}) of CN ($r > 0.01$ μm) and aerosol with radius > 0.15 μm in 12 sizes. Right hand panel: ozone mixing ratio (top axis) and temperature (bottom axis). For reference the temperature is compared to equilibrium coexistence temperatures for nitric acid trihydrate and ice which form within polar stratospheric clouds.

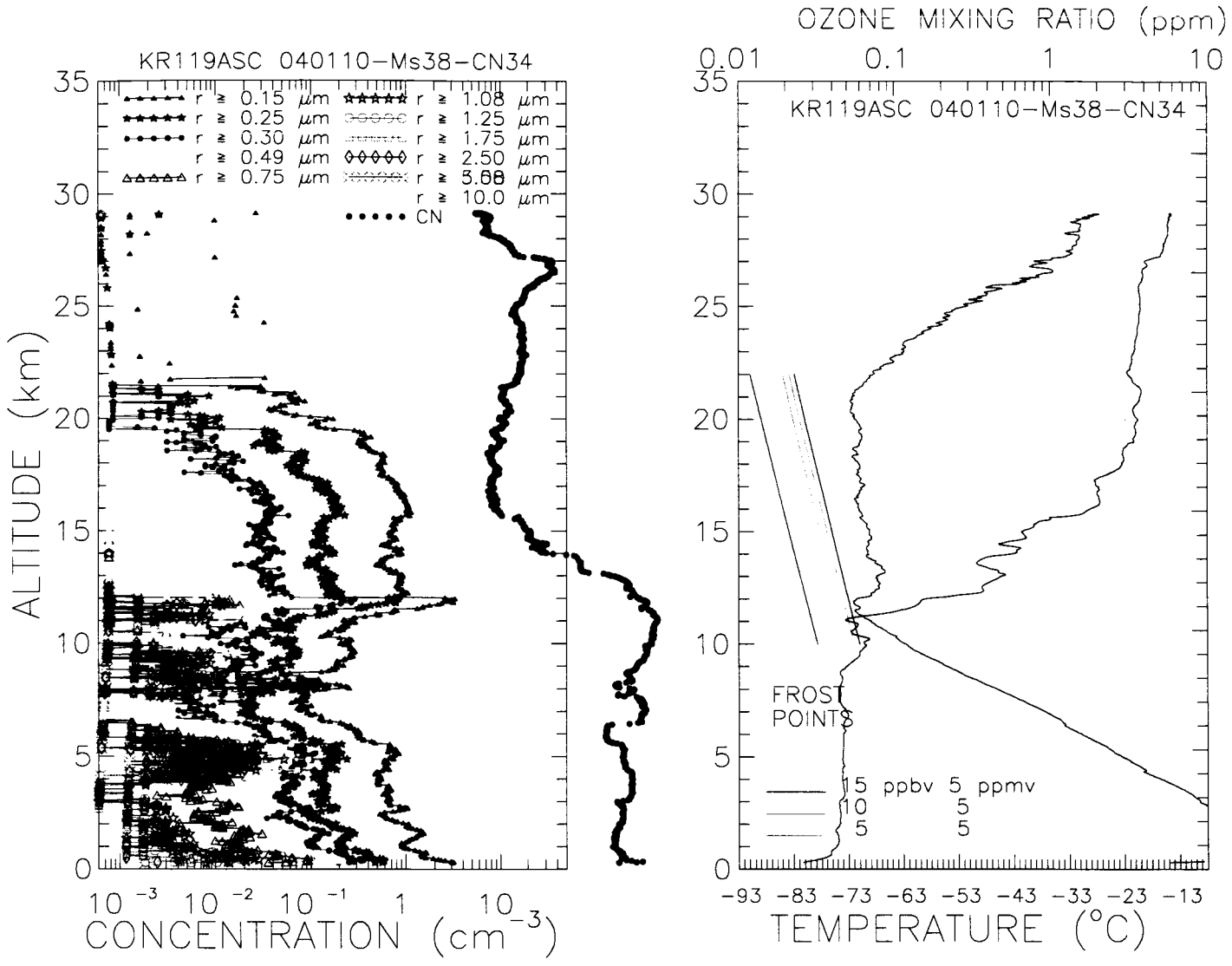

Figure 3. Balloon-borne measurements completed on 10 January 2004. The balloon was released from Esrange, Sweden. Left hand panel: vertical profiles of the concentration (cm^{-3}) of CN ($r > 0.01$ μm) and aerosol with radius > 0.15 μm in 12 sizes. Right hand panel: ozone mixing ratio (top axis) and temperature (bottom axis). For reference the temperature is compared to equilibrium coexistence temperatures for nitric acid trihydrate and ice which form within polar stratospheric clouds. Clearly there were no polar stratospheric clouds observed on this day.